ATTRACTION OF ADULT *PHYLLOTOCUS NAVICULARIS* BLANCHARD AND *EUPOECILA AUSTRALASIAE* (DONOVAN) (COLEOPTERA: SCARABAEIDAE) TO VOLATILE COMPOUNDS

P.G. ALLSOPP and R.H. CHERRY[1]

Bureau of Sugar Experiment Stations, P.O. Box 651, Bundaberg, Qld, 4670.

Abstract

Japanese beetle traps baited with anethole attracted 20-36 times more adults of *Phyllotocus navicularis* than did unbaited traps. In one of two tests eugenol and a Trécé floral lure (10: 22: 11 2-phenylethylpropionate: eugenol: geraniol) attracted significantly more *P. navicularis* than did the unbaited traps. Competition from flowering plants may explain the difference in attractiveness between the two tests. *Eupoecila australasiae* was attracted to anethole and less so to geraniol and the Trécé floral lure.

Introduction

Food-type lures have been used since the 1920s for trapping Japanese beetles, *Popillia japonica* Newman (Fleming, 1969), and have since been tested as attractants for a variety of other scarabs (Osborne and Hoyt, 1968; Tashiro *et al.*, 1969; Williams and Miller, 1982; Donaldson *et al.*, 1986; Klein and Edwards, 1989; Williams *et al.*, 1990). No information is available on the attractiveness of food-lures to Australian scarabs.

The melolonthine *Phyllotocus navicularis* is a household nuisance pest in southern Queensland, being attracted to white items on washing lines, and is common in flowers during spring. The cetoniine *Eupoecila australasiae* is often seen feeding on nectar in flowers during summer and is a strong diurnal flier. Here we report on their attraction to some of the food-type lures being tested in Queensland against canegrub beetles.

Materials and Methods

We tested lures by exposing them in Catch-can Japanese beetle traps (Trécé Inc., Salinas) near Bundaberg, south-eastern Queensland. Traps were hung 1 m above the ground on steel rods 10 m apart. The lures tested were anethole (1-methoxy-4-(1-propenyl)benzene), eugenol (2-methoxy-4-(2-propenyl) phenol), citral (3,7-dimethyl-2,6-octadienal), citronellal (3,7-dimethyl-6-octenal), geraniol (3,7-dimethyl-2,6-octadien-1-ol), hexanoic acid, pentanoic acid, eucalyptus oil (Double "D" Eucalyptus Oil, Sheldon Drug Co, Sydney), and the standard Trécé Japanese beetle floral lure (10:22:11, 2-phenylethylpropionate: eugenol: geraniol). Chemicals evaporated from a covered piece of sponge 4 x 4 x 1 cm placed in the same position in the trap as the standard Trécé lure. Every 2-3 days of each test, 5 ml of the appropriate lure were added to the sponges. Standard Trécé lures were not replaced during each test.

Phyllotocus navicularis

We conducted three tests at two sites. In test 1 we exposed one trap with

[1]*Present address: University of Florida, Everglades Research and Education Center, P.O. Box 8003, Belle Glade, FL 33430, USA*

each lure and one unbaited trap for 12 consecutive days from 10 October 1989. Traps were arranged randomly in a line on the edge of a sugarcane field adjacent to native forest. Beetles were counted each 2 days, making six replicates in time. Test 2 comprised three replicates of the nine lures and an unbaited control arranged in a randomised block design in a sugarcane field. Beetles were counted after 7 days exposure from 3 November 1989. Test 3 compared only anethole and unbaited traps at the same site as test 1. Lures were replicated five times in a randomised block design and beetles were counted after 7 days exposure commencing on 23 October 1989.

Eupoecila australasiae

We exposed lures in two tests at one site in a sugarcane field. In test 1 we exposed three replicates of the nine lures and one unbaited control for 7 days from 22 December 1989. In test 2 we exposed six replicates of traps each with either anethole, eugenol, geraniol or the Trécé lure or unbaited for 7 days from 3 January 1990. Both tests used a randomised block design.

Analysis

As none of the raw data sets were normally distributed ($P < 0.01$, Shapiro-Wilk test for normality) and were not normalised by transformation, they were analysed using the non-parametric Friedman two-way analysis of variance (Conover, 1980).

Results

Phyllotocus navicularis

In test 1 anethole attracted significantly ($P < 0.05$) more *P. navicularis* than did any other lure, whilst in test 2 anethole attracted significantly more than all lures except eugenol and the Trécé lure (Table 1). The attractiveness of anethole was confirmed in test 3. Anethole attracted 20-36 times as many beetles as the unbaited controls; only 4 *P. navicularis* were caught in unbaited traps, 1 each in tests 1 and 2 and 2 in test 3. In test 2 eugenol and the Trécé lure attracted significantly ($P < 0.05$) more *P. navicularis* than did the unbaited controls. The addition of 2-phenylethylpropionate and geraniol in the Trécé lure did not make a significant improvement upon the attractiveness of eugenol alone.

Eupoecila australasiae

In both tests no *E. australasiae* were caught in the unbaited traps (Table 1). In test 1 anethole attracted significantly ($P < 0.05$) more beetles than any other lure except the Trécé lure. In test 2 the Trécé lure and geraniol attracted significantly fewer beetles than did anethole. Citral, citronellal, eucalyptus oil, hexanoic acid and pentanoic acid did not attract this species. The presence of eugenol and 2-phenylethylpropionate in the Trécé lure did not significantly improve the lure's attractiveness over geraniol alone.

Discussion

Single chemicals were more attractive to *P. navicularis* and *E. australasiae* than was the Trécé lure mixture. This contrasts with *P. japonica* where mixtures are more effective attractants than are single chemicals (Fleming, 1969; Ladd and McGovern, 1980). It parallels the attraction of South African cetoniines and rutelines and the American cetoniine *Euphoria sepulchralis* (F.) to single chemicals (Donaldson *et al.*, 1986; Cherry unpubl. data). This may be because adult cetoniines and some rutelines feed on fruit and flowers whereas Japanese beetles have a more varied diet including leaves as well as fruit and flowers (Donaldson *et al.*, 1986). *P. navicularis* has similar habits to cetoniines being a diurnal flier and attracted to flowers.

Table 1. Catches of *P. navicularis* and *E. australasiae* in traps containing aromatic lures.

Lure	*P. navicularis* No./trap/day*			*E. australasiae* No./trap /week*	
	Test 1	Test 2	Test 3	Test 1	Test 2
Anethole	2.5a	1.8a	1.2a	3.0a	4.8a
Eugenol	0.1cd	0.4ab		0.3cd	0.3c
Citral	0.1cd	0.05c		0.0d	
Citronellal	0.4bc	0.05c		0.0d	
Geraniol	0.05cd	0.2bc		1.0bc	1.7b
Eucalyptus oil	0.0d	0.05c		0.0d	
Hexanoic acid	0.4b	0.05c		0.0d	
Pentanoic acid	0.0d	0.1bc		0.0d	
Trécé lure	0.0d	0.4ab		1.3ab	1.8b
Unbaited	0.08cd	0.05c	0.06b	0.0d	0.0c

* Means are original values. In each test, values followed by the same letter are not significantly different at the 5% level.

The attractiveness of anethole and eugenol is strikingly similar to that in honey bees *Apis mellifera* L. (Ladd *et al.*, 1974; Ladd and Tew, 1983; Allsopp and Cherry, 1991). *Phyllotocus* spp. and *E. australasiae* are commonly found swarming on both native and exotic flowers (Tillyard, 1926; Alderson, 1976; Moore, 1986) and *P. macleayi* Fischer swarms around beehives, apparently attracted by the smell of honey (Britton, 1957). Anethole and eugenol are common constituents of plant oils (Windholz, 1983) and it may be their influence which attracts *P. navicularis* and *E. australasiae* to flowers and hives.

The difference in attractiveness of eugenol to *P. navicularis* between tests 1 and 2 may be related to competition from flowering plants. Test 1 was adjacent to native forest in which *Grevillia banksii* was flowering. In test 2 all traps were within fields of newly-ratooned sugarcane where there were no flowering plants. We have observed a similar attractiveness of eugenol to honey bees when traps are placed in sugarcane fields free of flowering plants (Allsopp and Cherry, 1991).

Although neither *P. navicularis* nor *E. australasiae* cause significant damage to crop plants, *P. navicularis* is a nuisance pest soiling washing, particularly white items. The further development of traps and synthetic attractants may provide a method for reducing this.

Acknowledgements
We thank Norm McGill and Greg Sullivan for technical assistance and the Sugar Research and Development Corporation for financial support through project BS34S. RHC was on sabbatical leave from the University of Florida.

References

ALDERSON, J. 1976. Behaviour and larvae of two rose chafer beetles *Eupoecila australasiae* (Don), *Diaphonia dorsalis* (Don) (Coleoptera: Scarabaeidae, Cetoniinae). *Victorian Naturalist* **93:** 86-91.

ALLSOPP, P.G. and CHERRY, R.H. 1991. Attraction of *Apis mellifera* L. (Hymenoptera: Apidae) to volatile compounds. *Journal of the Australian Entomological Society* **30:** 219-220.

BRITTON, E.B. 1957. *A revision of the Australian chafers (Coleoptera: Scarabaeidae: Melolonthinae)*. Vol. 1. 185 pp. British Museum (Natural History), London.

CONOVER, W.J. 1980. *Practical nonparametric statistics*. 493 pp. Wiley, New York.

DONALDSON, J.M.I., McGOVERN, T.P. and LADD, T.L. 1986. Trapping techniques and attractants for Cetoniinae and Rutelinae (Coleoptera: Scarabaeidae). *Journal of Economic Entomology* **79:** 374-377.

FLEMING, W.E. 1969. Attractants for Japanese beetle. *Technical Bulletin, U.S. Department of Agriculture* **1399**.

KLEIN, M.G. and EDWARDS, D.C. 1989. Captures of *Popillia lewisi* (Coleoptera: Scarabaeidae) and other scarabs on Okinawa with Japanese beetle lures. *Journal of Economic Entomology* **82:** 101-103.

LADD, T.L. and McGOVERN, T.P. 1980. Japanese beetle: a superior attractant, phenethyl proprionate + eugenol + geraniol, 3:7:3. *Journal of Economic Entomology* **73:** 689-691.

LADD, T.L., McGOVERN, T.P. and BEROZA, M. 1974. Attraction of bumble bees and honey bees to traps baited with lures for Japanese beetle. *Journal of Economic Entomology* **67:** 307-308.

LADD, T.L. and TEW, J.E. 1983. Attraction of honey bees (Hymenoptera: Apidae) to traps baited with lures for Japanese beetles (Coleoptera: Scarabaeidae). *Journal of Economic Entomology* **76:** 769-770.

MOORE, B.P. 1986. *A guide to the beetles of south-eastern Australia*. Fascicle No. 7. Australian Entomological Press, Greenwich.

OSBORNE, G.O. and HOYT, C.P. 1968. A chemical attractant for males of the grass grub beetle *Costelytra zealandica* (White) (Col., Scarabaeidae). *Bulletin of Entomological Research* ***59:*** *81-83.*

TASHIRO, H., GYRISCO, G.G., GAMBRELL, F.L., FIORI, B.J. and BREITFELD, H. 1969. Biology of the European chafer *Amphimallon majalis* (Coleoptera: Scarabaeidae) in northeastern United States. *Bulletin of the New York State Agricultural Experiment Station* **828.**

TILLYARD, R.J. 1926. *The insects of Australia and New Zealand.* 560 pp. Angus and Robertson, Sydney.

WILLIAMS, R.N., McGOVERN, T.P., KLEIN, M.G. and FICKLE, D.S. 1990. Rose chafer (Coleoptera: Scarabaeidae): improved attractants for adults. *Journal of Economic Entomology* **83:** 111-116.

WILLIAMS, R.N. and MILLER, K.V. 1982. Field assay to determine attractiveness of various aromatic compounds to rose chafer adults. *Journal of Economic Entomology* **75:** 196-198.

WINDHOLZ, M. (Ed.) 1983. *The Merck index. An encyclopedia of chemicals, drugs, and biologicals.* 1463 pp. Merck, Rahway.